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CERN - PS DIVISION

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KEK – CERN COLLABORATION MEETING FOR THE RF SYSTEM OF LEIR

(CERN, 10-11 June 2002)

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Geneva, Switzerland
July 2002

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Introduction

In the framework of the collaboration between the KEK Laboratory and CERN for the realization of the RF cavities of LEIR, meetings were held at CERN from 10th to 12th of June 2002 for perfecting technical aspects and refining the schedule. A previous meeting, held in March 2002 at KEK, outlined the general lines of this joint work [1].

1. RF Cavities

In the last few months, several tests have been performed at KEK on FINEMET cores to study the problem of corrosion by water in direct cooling systems (cavities where the cores are immersed into the cooling water flow) and a technique has been developed to coat each core with an epoxy paint and an organic silicon layer. This technique has been successfully tested using the process adopted for stainless steel certification (immersion into a 6% $FeClO_3$ solution at 40 °C for 24 hours). For the time being, only two layer thicknesses of 0.1 and 0.5 mm have been considered. Further tests will be performed in order to decide the optimum thickness of the organic Si coating [2] and to understand the effects of mechanical and thermal stress. The maximum permissible pressure at the cooling water inlet has been estimated in 5 bars.

The KEK representatives also volunteered to perform some measurements on the HIMAC cavity, in order to check the technical solutions that are envisaged for the LEIR cavity. A short five-hour shutdown, foreseen on June 17th 2002, will allow for some measurements and, in case of need, the longer shutdown of the HIMAC accelerator, foreseen in August 2002, could be used. These tests will allow to decide the final geometry of the LEIR RF cavity and its coupling to the RF amplifier.

Before the end of October 2002, CERN will provide assembly drawings of the full LEIR RF installation (cavity + vacuum chamber) including the required modification to the HIMAC original design, in order to comply with the LEIR machine requirements. KEK will produce the drawings for the manufacturing of the cavity and will deliver these drawings to CERN in the format required for their entering into EDMS (Electronic Data Management System, the standard CERN procedure for archiving design information on accelerators' components). To this end a list of general rules for EDMS compatibility will be sent to KEK.

The cavity will be delivered in pieces to CERN where it will be assembled with KEK's technical support, which is an integral part of this collaboration. A very simple support for the cavity leaving a 10 cm clearance between the cavity itself and the base will be fabricated at KEK. On the base of this support an aperture will be milled in order to allow a way out for cables in case of need. The total weight of the cavity without water can be estimated at around 600 kg.

The following is a detailed schedule of the collaboration milestones until the delivery of the two LEIR RF Cavities to CERN:

June 2002	First electrical tests on the HIMAC cavity in Chiba.
August 2002	Possibility of further tests on the HIMAC cavity.
October 2002	CERN sends the drawings of the LEIR RF installation, with the details of the modifications required by the LEIR installation to KEK.
January 2003	Starting of the production of two complete cavity assemblies at KEK.
After March 2003 (New production line for FINEMET started at Hitachi Metals)	CERN places the order for 12 FINEMET cores, which will be delivered to KEK for coating and then to CERN after the electrical tests have been performed.
July 2003	Expected delivery of the cores to KEK for testing.
August – September 2003	Complete dimensional and electrical checks on the cores. Check of the cavity impedance.
From October 2003	Cavities and cores available for further tests and shipping to CERN
April 2004	Deadline for the delivery of cavities and cores to CERN. [~ 2 man.months of KEK manpower at CERN to help with assembly and test]

At the end of this collaboration, all documentation and information necessary to build more cavities will be made available to CERN.

2. RF Driver Amplifiers

The following specifications for the solid-state driver amplifiers have been agreed between CERN and KEK representatives. CERN will develop, build and test modules, which will be used for both applications. Enough modules will be delivered by CERN at KEK to assemble a 6 kW prototype, where CERN technical support will be provided at this stage as an integral part of the collaboration. KEK will take care of developing the power combiner. Power supplies are not part of the CERN deliverables.

If afterwards the decision is taken at KEK to build more driver amplifiers, CERN will provide all the documentation and information to allow the necessary construction.

Parameter	CERN	KEK	Notes
Output Power @ 1dB compression point	1 kW	6 kW or 2x3 kW	For KEK the required number of 1 kW units will be combined.
Duty Factor	100 %	50 %	20ms RF Burst repeated at 25 Hz
-1dB Bandwidth	0.7-5.0 MHz	1.2-5.1 MHz	
Gain	55+/-1 dB		
Gain Linearity	< 3 dB		1 W to 1 kW
Harmonic Distortion	< 15 dBc		Goal value < 20 dBc
DC Power Supply AC Power Supply	35-50 V - 100 A 100-220 V 50Hz Single Phase		For each 1 kW module
Cooling	Water		6 bar, 20 liters/min , 20-30°C
Input/ Output Impedance	50 Ω		
Monitoring	Forward and reflected RF and detected signals. Individual modules current monitors.		
Protections	Temperature Current (fuses)		A 'Warning' signal is generated when temperature approaches the limit value. After the warning signal has been generated, the amplifier must continue to operate for 20ms at full power and 2s at 30% of the nominal power. The amplifier is then set in 'Error' mode and shut down. Following the blow up of one or more fuses a 'Warning' signal is generated. The amplifier will continue to operate for 20ms at maximum power available and 2s at 30% of the nominal power or maximum power available whichever is lower. The amplifier is then set in 'Error' mode and shut down.
Remote Indication	Temperature OK Fuses OK All Modules OK		Floating opto-coupler output.

RF connectors : Lemo 00, SMA, BNC, N.
Control connectors : Cannon.
DC Supply : Direct connection.
Water Connectors : ½" gas

Production Schedule

June 2002	Specification Definition
October 2002	1 kW Prototype Design
January 2003	First 1 kW Prototype Manufactured
March 2003	First 1 kW Module Tested at CERN
April 2003	Full Documentation Available
September 2003	Production of 1 kW Amplifier Units
October 2003	Test of 1 kW Amplifier Units
November 2003	Shipping to KEK [~ 2 man months of CERN manpower at KEK to help with assembly and test]

References

[1] R. Garoby, M. Paoluzzi, Collaboration with KEK for the RF of LEIR – Travel Report, PS/RF/ Note 2002-049, CERN, Geneva.

[2] C. Ohmori et Al., High Field Gradient Cavity for JAERi-KEK Joint Project, Proceedings of the 2002 European Particle Accelerator Conference, Paris.